



Critical Infrastructure Logical Dependencies and Interdependencies

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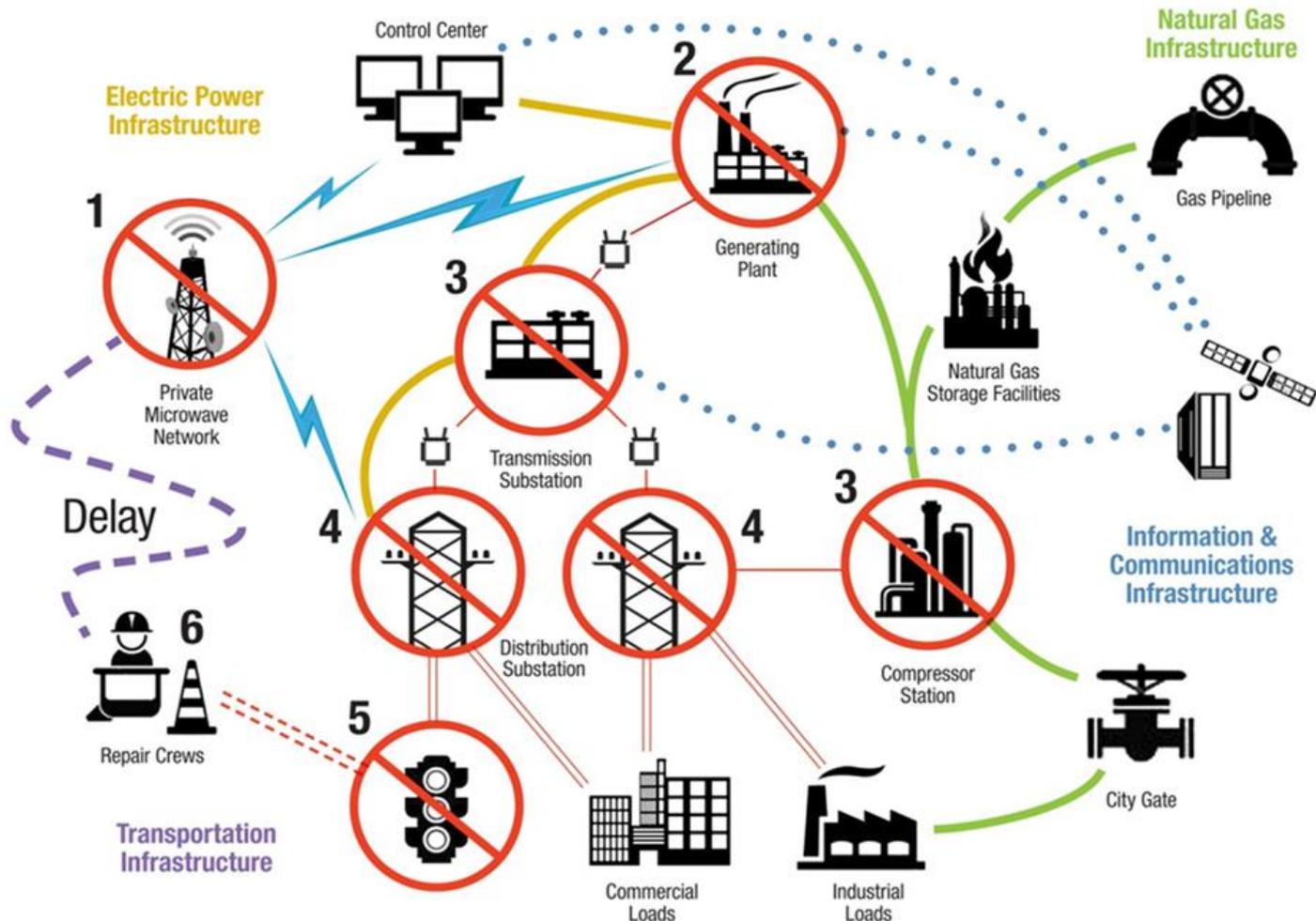
by

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Critical Infrastructure Dependencies and Interdependencies



Dependency and Interdependency Concepts (1/2)

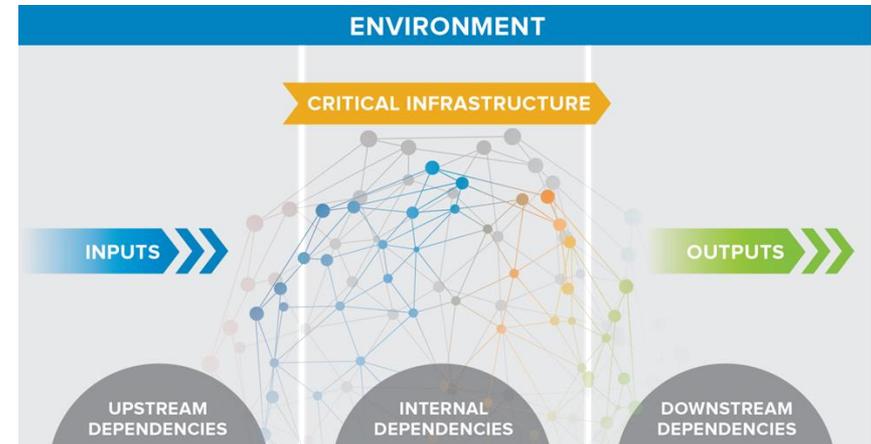
■ Dependency

“linkage or connection between two infrastructures, by which the state of one infrastructure influences or is reliant upon the state of the other.”*



■ Interdependency

“bidirectional relationship between two infrastructures in which the state of each infrastructure influences or is reliant upon the state of the other.”*



Four classes of dependencies

- Physical
- Cyber
- Geographic
- Logical

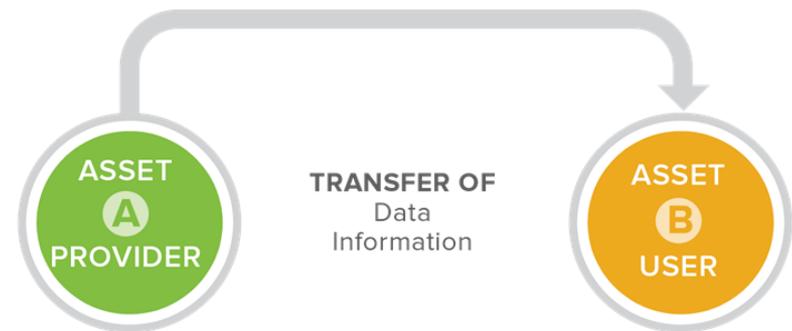
* Rinaldi, Peerenboom, and Kelly, 2001

Dependency and Interdependency Concepts (2/2)

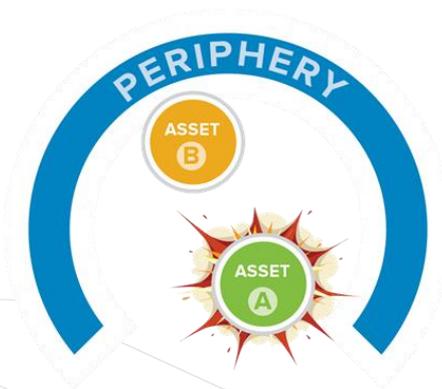
Physical



Cyber



Geographic



Logical

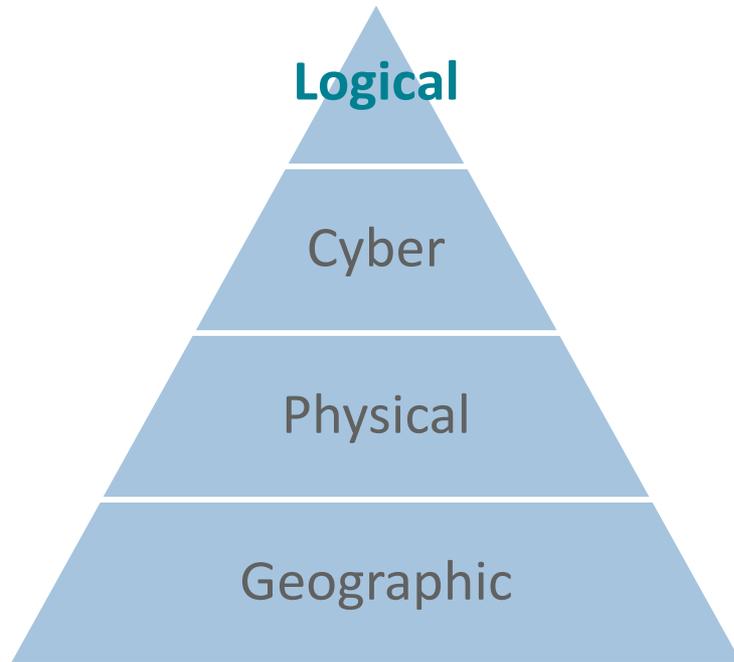


Other Dependency Taxonomies

- 2003 - Los Alamos National Laboratory: **physical, logical, or functional connections**
- 2006 – Idaho National Laboratory - Pederson, Dudenhoeffer, Hartley, and Permann

Interdependency Category	Definition
Physical	A requirement, often engineering reliance between components . For example: a tree falls on a power line during a thunderstorm resulting in a loss of power to an office building and all the computers inside.
Informational	An informational or control requirement between components . For example: a supervisory control and data acquisition (SCADA) system that monitors and controls elements on the electrical power grid. A loss of the SCADA system will not by itself shut down the grid, but the ability to remotely monitor and operate the breakers is lost.
Geospatial	A relationship that exists entirely because of the proximity of components . For example, flooding or a fire may affect all the assets located in one building or area.
Policy/Procedural	An interdependency that exists due to policy or procedure that relates a state or event change in one infrastructure sector component to a subsequent effect on another component.
Societal	The interdependencies or influences that an infrastructure component event may have on societal factors such as public opinion, public confidence, fear, and cultural issues . Even if no physical linkage or relationship exists, consequences from events in one infrastructure may impact other infrastructures.

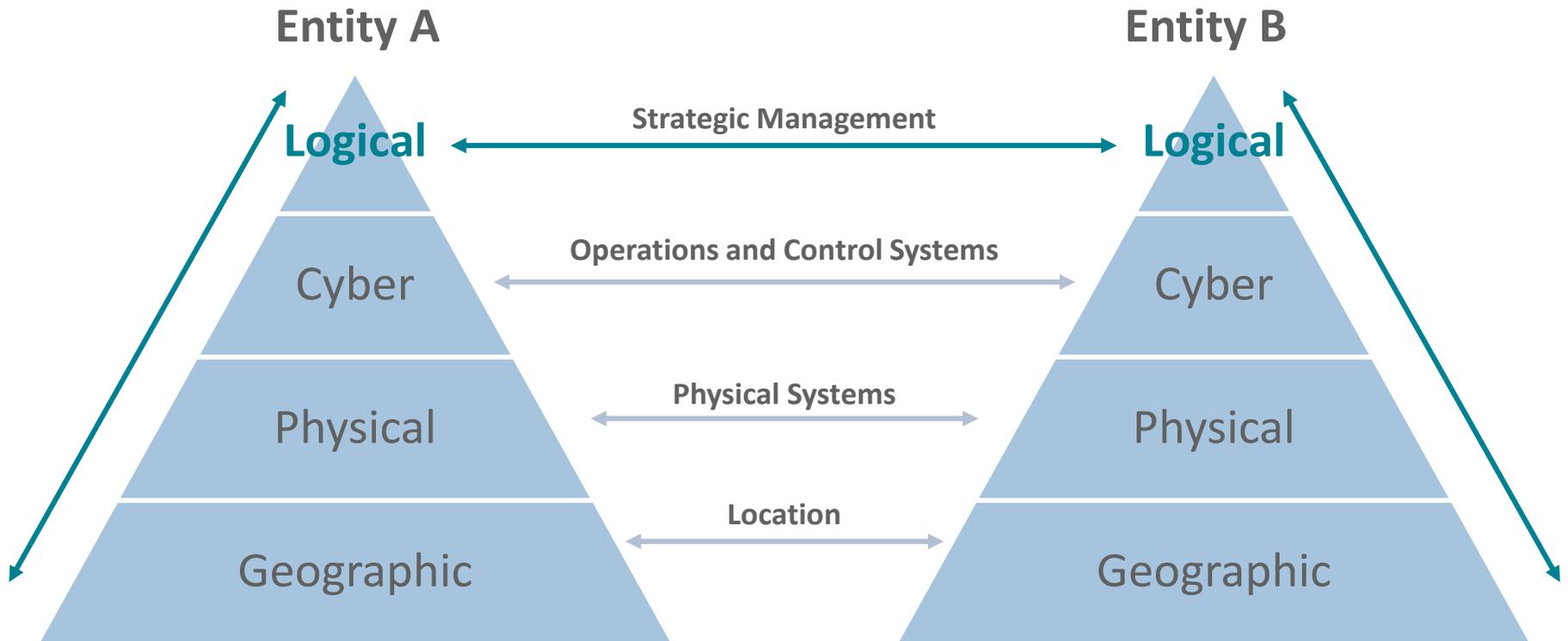
What are Logical Dependencies?



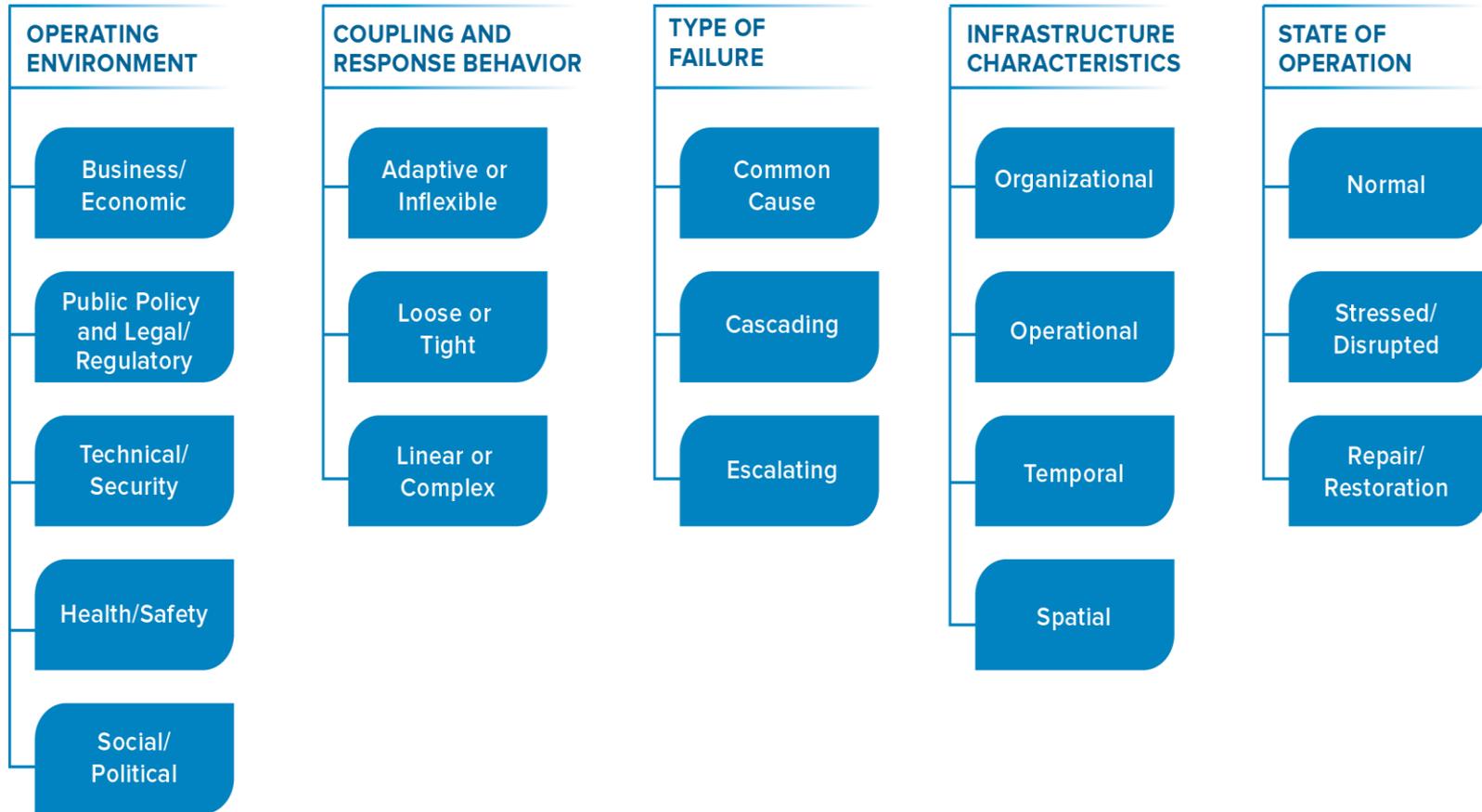
Strategic Management

- **Operations**
 - Administrative tasks necessary to oversee assets, direct activities, and “harvest” value.
- **Logistics**
 - Coordination of processes necessary to acquire materials, create products or services, and distribute to users.
- **Continuity**
 - Preparedness efforts to ensure that critical functions continue to operate despite incidents or can be recovered within a reasonably short period.
- **Development**
 - Creation of future opportunities for growth and long-term value.

How is Infrastructure Logically Dependent?



Dependency and Interdependency Dimensions



Rinaldi, Peerenboom, and Kelly, 2001

What Internal and External Factors Influence Logical Dependencies?

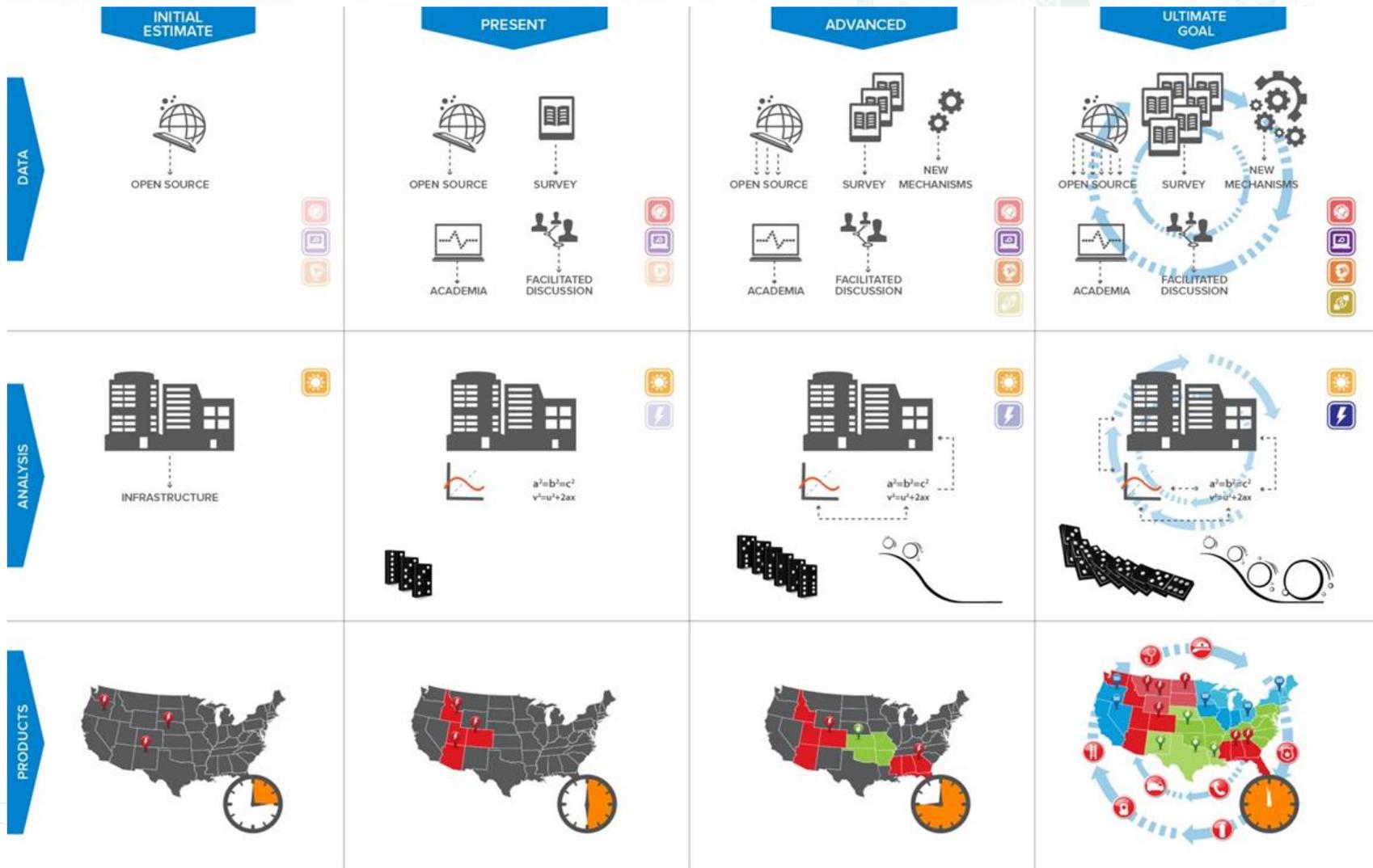
Logical

Strategic Management

- Operations
- Logistics
- Continuity
- Development

- **Legal and Policy Influences**
 - Regulations
 - Industry standards
 - Protections
 - Lobbying
- **Business and Economic Influences**
 - Supply chains (upstream)
 - Customer demand (downstream)
 - Competition/Market forces
 - Tax/Incentives
- **Social Influences**
 - Access/Cost
 - Satisfaction/Reputation
 - Human Capital
 - Corporate Responsibility

Four Phases of Development



How do we incorporate logical dependency assessment into Infrastructure Analyses?

▪ Data

- Mission, goals, and benchmarks
- Management and staff requirements (full and partial operation)
- Financial and operating budgets
- Internal and external rules and procedures
- Plans and training details
- Communication, information sharing, and partnerships

▪ Analysis

- Indicators measuring proactive and reactive capacities
- Performance metrics for long- and short-term management strategies

▪ Products

- Link strategic management to success/failure of physical and cyber elements
- Link logical dependencies of one entity to another entity a/o larger operating theater

What are the benefits for Critical Infrastructure Community? (1/2)

▪ Facility/Sector Application

– Chalk River Laboratories Shutdowns, 2009

- Produces **1/3 of the world's supply of medical radioisotopes**
- Several **government-mandated shutdowns** between 2007-2009 due to **heavy water leaks**
- Because 2009 shutdown occurred at a time when only 1 of the other 4 worldwide medical isotope reactors was producing, there was a **worldwide shortage**
- **Availability of essential supply chain can be impacted by government mandates related to safety, management, and oversight**

– Lac-Mégantic Rail Disaster, 2013

- Train carrying shipment of oil derailed near Sherbrooke and exploded, **destroying 30 buildings and killing 47 people**
- **Operating procedures** allowed for a) only one engineer to control locomotive, b) the use of only one set of brakes while parked, and c) for a locomotive to be left running while unattended.
- Subsequent inquiries forced rule changes to policies governing the management of rail shipments that had resulted in the derailment

What are the benefits for Critical Infrastructure Community? (2/2)

▪ Global Application

– Climate Change

- Every infrastructure sector will be **impacted to some degree by climate change impacts**
- Guidance on the implementation of adaptation and mitigation strategies frequently **centers on legal, political, economic, social considerations**:
 - Kyoto Protocol, United Nations Framework Convention on Climate Change
 - Climate Action Plan, Executive Office of the President
 - Quadrennial Energy Review (QER), U.S. Department of Energy
- Also requires that **individual critical infrastructure owners and operators be able to develop strategy for new technology and economic environments**:
 - Considers current and future needs and requirements
 - Anticipates how sectors will operate together in the future
 - Avoids competitive disadvantage for early adopters
 - Incentivizes changes in processes and materials

Conclusion

- **Understand consequences of dependencies and interdependencies over time** in order to develop mechanisms to manage preparedness, mitigation, response, and recovery.
- **Several dimensions** must be considered (i.e., operating environment, coupling and response behavior, type of failure, infrastructure characteristics, and state of operation).
- **Logical dependencies apply at management level** and include the strategic management activities related to the operation, logistics, continuity, and development of infrastructure.
- **Strategic management** may be influenced by internal and external forces including law and policy, business and economic, and social considerations.
- **Necessity to build adaptive and flexible approaches** that can evolve over time and allow the implementation of innovative capabilities.
- **Information sharing** between providers, sectors, government, and the public is necessary in order build awareness of how dependent and interdependent infrastructure and processes may be impacted by management decisions.

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